PB-239 543

WATERBURY RESERVOIR, WASHINGTON AND LAMOILLE COUNTIES, VERMONT

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Vermont National Guard
Vermont State Agency of Environmental Conservation

July 1974

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. PB 239 543

4. TITLE AND SUBTITLE
Report on Waterbury Reservoir, Washington and Lamoille Counties, Vermont

5. REPORT DATE
Prepared July 1974

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Anonymous (National Eutrophication Survey Staff)

8. PERFORMING ORGANIZATION REPORT NO.
Working Paper # 18

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Pacific Northwest Environmental Research Laboratory
U.S.Environmental Protection Agency
200 S. W. 35th St.
Corvallis, Oregon 97330

10. PROGRAM ELEMENT NO.
1BA029

11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. Environmental Protection Agency
Office of Research and Development
Washington, D.C.

13. TYPE OF REPORT AND PERIOD COVERED
Final - 1972

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release unlimited		37
	20. SECURITY CLASS *(This page)*	22. PRICE
		3.75-2.25

EPA Form 2220-1 (9-73)

REPORT
ON
WATERBURY RESERVOIR
WASHINGTON AND LAMOILLE COUNTIES
VERMONT

EPA REGION I

WORKING PAPER No. 18

WITH THE COOPERATION OF THE

VERMONT AGENCY OF ENVIRONMENTAL CONSERVATION

AND THE

VERMONT NATIONAL GUARD

JULY, 1974

CONTENTS

	Page
Foreword	ii
List of Vermont Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Introduction	3
III. Lake and Drainage Basin Characteristics	4
IV. Lake Water Quality Summary	5
V. Nutrient Loadings	11
VI. Literature Reviewed	17
VII. Appendices	18

FOREWORD

The National Eutrophication Survey was initiated in 1972 as a research project in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected fresh water lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can, in fact, be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

This report documents the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin. It is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/ standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Vermont Agency of Environmental Conservation for professional involvement and to the Vermont National Guard for conduct of the tributary sampling phase of the Survey.

Martin L. Johnson, Secretary of the Vermont Agency of Environmental Conservation; Gordon R. Ryper, Commissioner of the Water Quality Division; David L. Clough, Director, James W. Morse II, Biologist, and Wally McLean, Sanitary Engineer, of the Water Quality Division, provided invaluable lake documentation and counsel during the study. Reginald A. LaRosa, Director of the Water Supply and Pollution Control Division, and James F. Agan, Chief of the Operations Section of the Environmental Engineering Division, were most helpful in arranging for the sampling of wastewater treatment plants involved in the Survey.

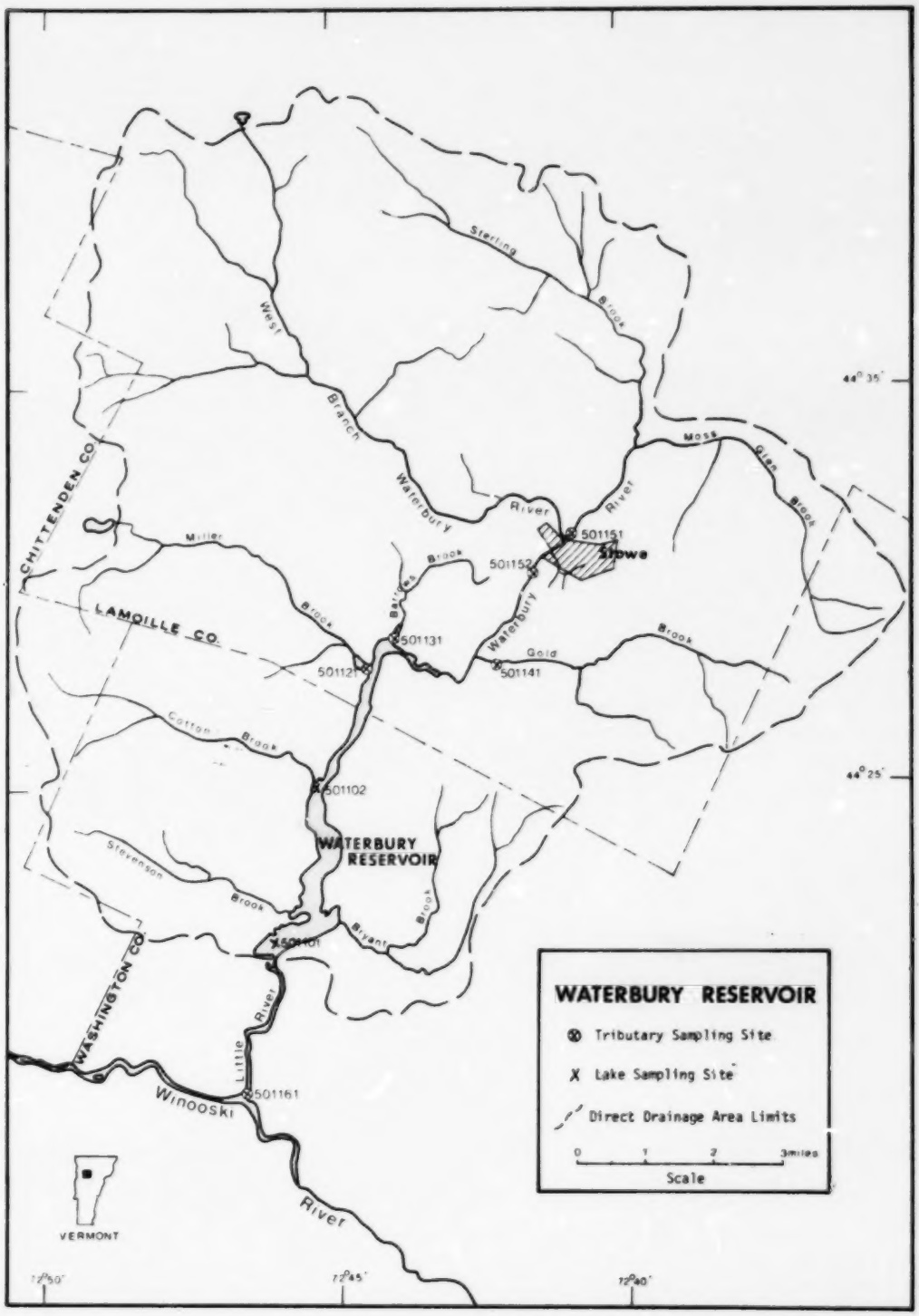
Major General Reginald M. Cram, the Adjutant General of Vermont, and Project Officer Major Howard Buxton, who directed the volunteer efforts of the Vermont National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF VERMONT

LAKE NAME	COUNTY
Arrowhead Mountain Lake	Chittenden, Franklin
Clyde Pond	Orleans
Harriman Reservoir	Windham
Lake Champlain	Addison, Chittenden, Franklin
Lake Lamoille	Lamoille
Lake Memphremagog	Orleans
Waterbury Reservoir	Washington, Lamoille


Sterling
Brook
West
Branch
Waterbury
River
Moss
Glen
Brook
44° 35'
CHITTENDEN CO
Miller
Brook
501151
Stowe
501152
Bartlett
Brook
LAMOILLE CO
501131
Waterbury
River
Gold
Brook
501121
501141
Cotton
Brook
44° 25'
501102
WATERBURY
RESERVOIR
Stevenson
Brook
Bryant
Brook
501101
WASHINGTON CO
Little
River
Winooski
501161
River
VERMONT
72° 50'
72° 45'
72° 40'
WATERBURY RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Direct Drainage Area Limits
0
1
2
3miles
Scale

WATERBURY RESERVOIR

STORET NO. 5011

I. CONCLUSIONS

A. Trophic Condition:

Survey data show that Waterbury Reservoir is mesotrophic. Of the other six Vermont water bodies studied, none had less mean total and dissolved phosphorus (Waterbury compares very well with oligotrophic Moosehead and Rangeley lakes in Maine in this respect), only mesotrophic Harriman Reservoir had greater Secchi disc transparency, only two Vermont water bodies had less mean chlorophyll a, but only Harriman Reservoir had a greater level of mean inorganic nitrogen. Some depression of dissolved oxygen with depth occurred at station 1 in August, 1972, but the lowest concentration measured was still 48% of saturation.

Survey limnologists noted the good appearance of Waterbury Reservoir on all sampling visits; and no algal concentrations were evident.

B. Rate-Limiting Nutrient:

Because of the atypical growth response of the test alga, Selenastrum capricornutum, the algal assay results are not considered reliable. However, the lake data indicate phosphorus limitation at all sampling times; i.e., N/P ratios were 55/1 or greater, and phosphorus limitation would be expected.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Waterbury Reservoir received a total phosphorus load at a rate just a little less than a eutrophic rate (see page 15). Of this load, it is estimated that the Village of Stowe contributed over 39%. It is calculated that 80% removal of phosphorus at this source would reduce the loading rate to 8.2 lbs/acre/yr or 0.92 $g/m^2/yr$ (a mesotrophic loading rate).

It is concluded that 80% phosphorus removal at the Village of Stowe would protect the existing mesotrophic condition of Waterbury Reservoir.

At the time of preparation of this report, the preliminary engineering report on tertiary wastewater treatment facilities, with phosphorus removal, has been approved, and the next higher phase of planning is underway.

2. Non-point sources--The mean annual nutrient exports of the Waterbury River were significantly higher than the exports of the other two Waterbury Reservoir tributaries studied (see page 15). However, since the waste discharge of the Village of Stowe was not sampled, the apparent higher export rates may be due only to underestimation of the Stowe nutrient loads, but a need for further study is indicated.

II. INTRODUCTION

Waterbury Reservoir, located in Washington and Lamoille Counties, was formed in 1930 by construction of a dam by the U. S. Army Corps of Engineers which impounded the Little River. The purpose of the reservoir was primarily flood control and hydroelectric power generation by the Green Mountain Power Company which operates a 5,520 kilowatt plant at the dam.

The land surrounding the reservoir is owned by the State of Vermont and there has been no private shoreline development; however, the reservoir is used by the public for fishing, boating, and other recreational activities. A public boat-launching site is located near the dam; and a State Park, located at the southwest corner of the reservoir, provides access for fishing, swimming, and camping.

Reportedly (Anderson, 1969), Waterbury Reservoir supports only a mediocre fishery due to the water level fluctuations (as much as 50 feet) resulting from the dual use of the reservoir for flood control and power generation; these water level fluctuations have prevented the reservoir banks from stabilizing and bank erosion has occurred. According to the report, the continual bank erosion has resulted in the suspension of fine clay particles in the water which has reduced light penetration and inhibited primary productivity. It was concluded that a good fishery in Waterbury Reservoir could not be expected until water level fluctuations are minimized.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry:

1. Surface area: 890† acres.
2. Mean depth: 41.6† feet.
3. Maximum depth: 100† feet.
4. Volume: 37,024† acre/feet.
5. Mean hydraulic retention time: 83 days†.

B. Tributary and Outlet:
(See Appendix A for all flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Waterbury River	52.6 mi^2	105.9 cfs
Miller Brook	13.2 mi^2	26.6 cfs
Barrows Brook	2.1 mi^2	4.2 cfs
Minor tributaries & immediate drainage -	42.7 mi^2	88.6 cfs
Totals	110.6 mi^2	225.3 cfs

2. Outlet -

Little River	112.0 mi^2**	225.3 cfs

C. Precipitation***:

1. Year of sampling: 46.4 inches.
2. Mean annual: 35.0 inches.

---

† At conservation pool level of 592 feet MSL.
* Drainage areas are accurate within ±1%; gaged flows are accurate within ±15%, and ungaged flows are accurate within ±20%.
** Includes area of reservoir.
*** See Working Paper No. 1, "Survey Methods".

IV. LAKE WATER QUALITY SUMMARY

Waterbury Reservoir was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was collected from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was collected for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. Maximum depths sampled were 70 feet at station 1 and 15 feet at station 2.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/05/72)		
Temperature (Cent.)	15.8	16.5	16.5	17.2
Dissolved oxygen (mg/l)	5.6	7.2	7.1	8.4
Conductivity (μmhos)	80	81	80	82
pH (units)	6.1	6.3	6.3	6.5
Alkalinity (mg/l)	23	24	24	26
Total P (mg/l)	0.006	0.006	0.006	0.008
Dissolved P (mg/l)	0.003	0.004	0.004	0.006
NO_2 + NO_3 (mg/l)	0.120	0.146	0.130	0.200
Ammonia (mg/l)	0.050	0.072	0.075	0.100
		ALL VALUES		
Secchi disc (inches)	72	94	85	144

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/02/72	1. Dinobryon	1,947
	2. Cryptomonas	289
	3. Flagellates	78
	4. Navicula	36
	5. Synedra	36
	Other genera	97
	Total	2,483
08/02/72	1. Dinobryon	1,465
	2. Polycystis	940
	3. Gloeocapsa	452
	4. Flagellates	271
	5. Cryptomonas	217
	Other genera	453
	Total	3,798
10/05/72	1. Dinobryon	301
	2. Flagellates	211
	3. Cryptomonas	191
	4. Polycystis	156
	5. Scenedesmus	50
	Other genera	372
	Total	1,281

2. Chlorophyll *a* -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
06/02/72	01	-
	02	7.5
08/02/72	01	5.8
	02	6.8
10/05/72	01	0.9
	02	5.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.005	0.168	0.1
0.006 P	0.011	0.168	0.1
0.012 P	0.017	0.168	1.2
0.024 P	0.029	0.168	3.7
0.060 P	0.065	0.168	3.5
0.060 P + 10.0 N	0.065	10.168	21.2
10.0 N	0.005	10.168	0.1

2. Discussion -

The control yield of the assay alga, *Selenastrum capricornutum*, indicates that the potential primary productivity of Waterbury Reservoir was quite low at the time the sample was collected. However, the growth of the test alga was atypical in the control sample and all spiked samples, except possibly in the combined N and P spike. At the indicated nutrient levels, the expected control yield would have been about

2 mg/l dry weight, and the expected yield of the 6 µg/l spike would have been about 5 mg/l dry weight (note, however, there was no increase in yield with this spike). The expected yield of the combined N and P spike would have been about 27 mg/l dry weight which approximates the actual yield. The cause of the atypical growth response is not known.

The lake data indicate Waterbury Reservoir was phosphorus limited at all sampling times; i.e., N/P ratios were 55/1 or greater, and phosphorus limitation would be expected.

D. Trophic Condition:

The Survey data show that Waterbury Reservoir is mesotrophic. Phosphorus concentrations were exceptionally low, and the highest level of total phosphorus measured in any of the samples was 0.016 mg/l. Inorganic nitrogen concentrations were less impressive, but the highest level measured in any of the samples was only 0.59 mg/l.

Some depression of dissolved oxygen with depth occurred at station 1 in August, 1972, but the lowest concentration measured (4.5 mg/l) was still 48% of saturation; and, in the deepest sample taken (at 62 feet), the dissolved oxygen was 6.4 mg/l.

Among the Vermont water bodies studied, only Harriman Reservoir had greater Secchi disc transparency; and, during the Survey sampling, there was no evidence that the primary productivity of the

reservoir was inhibited by turbidity as previously reported (Anderson, 1969). However, the Survey sampling period was one of above-normal stream flows. From March to October, 1972, the outlet flows averaged about 1.5 times normal. Assuming that the reservoir remained relatively full due to high stream flows, bank erosion may have been relatively minor and turbidity due to bank erosion may have been less than usual during the summer of 1972.

V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Vermont National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May when two samples were collected. Sampling was begun in July, 1972, and was completed in June, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the New England District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of the U.S. Geological Survey computer program for calculating stream loadings ("STATPAC")*. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S) were estimated by using the means of the nutrient loads, in lbs/mi^2/year, in Miller Brook and Barrows Brook at stations 21 and 31 and multiplying the means by the ZZ area in mi^2.

The untreated wastes from the Village of Stowe were not sampled during the Survey, and nutrient loads were estimated*.

In this report, the nutrient loads attributed to the Waterbury River are those measured at station 52 minus the estimated loads from the Village of Stowe.

---

* See Working Paper No. 1, "Survey Methods".

A. Waste Sources:

1. Known municipal -

Name	Pop.* Served	Treatment	Mean** Flow (mgd)	Receiving Water
Stowe	1,200	None	0.120	Waterbury River

2. Known industrial - None

* The 1970 census of Stowe Village was 435; however, a population estimate of 1,200 was recommended by Vermont personnel to include the influx of tourists.

** Estimated; see Working Paper No. 1, "Survey Methods".

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Waterbury River	4,010	37.7
Miller Brook	320	3.0
Barrows Brook	130	1.2
b. Minor tributaries & immediate drainage (non-point load) -	1,840	17.3
c. Known municipal -		
Stowe	4,200	39.5
d. Septic tanks - None known	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	140	1.3
Total	10,640	100.0

2. Outputs -

Lake outlet - Little River 8,110

3. Net annual P accumulation - 2,530 pounds

* Estimated; see Working Paper No. 1, "Survey Methods".

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Waterbury River	208,680	55.1
Miller Brook	32,540	8.6
Barrows Brook	5,790	1.5
b. Minor tributaries & immediate drainage (non-point load) -	111,490	29.5
c. Known municipal -		
Stowe	11,280	3.0
d. Septic tanks - None known	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	8,570	2.3
Total	378,350	100.0

2. Outputs -

Lake outlet - Little River 344,140

3. Net annual N accumulation - 34,210 pounds

* Estimated; see Working Paper No. 1, "Survey Methods".

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr
Waterbury River	94	4,899
Miller Brook	24	2,465
Barrows Brook	62	2,757

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (1973). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	12.0	2.8	425.1	38.4
grams/m^2/yr	1.34	0.32	47.6	4.3

Vollenweider loading rates for phosphorus (g/m^2/yr) based on mean depth and mean hydraulic retention time of Waterbury Reservoir:

"Dangerous" (eutrophic rate)	1.40
"Permissible" (oligotrophic rate)	0.70

F. Controllability of Nutrients:

1. Point sources--During the sampling year, Waterbury Reservoir received a total phosphorus load at a rate of 12 lbs/acre/yr or 1.34

$g/m^2/yr$. Of this load, it is estimated that the only known point source, the Village of Stowe, contributed 39.5%. It is calculated that removal of 80% of the phosphorus from this source would reduce the loading rate to 8.2 lbs/acre/yr or 0.92 $g/m^2/yr$ and thus would result in a mesotrophic rate. It is concluded that this degree of phosphorus control would adequately protect the existing mesotrophic condition of Waterbury Reservoir.

It is noted that a preliminary engineering report on tertiary wastewater treatment facilities for the Village of Stowe, including phosphorus removal, has been approved by the Vermont Agency of Environmental Conservation, and the next higher phase of planning is underway (Morse, 1974).

2. Non-point source--The mean annual nutrient exports of the Waterbury River were significantly higher than the exports of the other two Waterbury Reservoir tributaries studied (the latter compare favorably with the phosphorus exports of unimpacted Vermont streams elsewhere in which the mean P export was 52 $lbs/mi^2/yr$ and the range was 30 to 65 $lbs/mi^2/yr$). The apparent higher export rates of the Waterbury River may be due only to underestimation of the nutrient loads from the Village of Stowe, but unknown point sources--such as septic tank discharges--may be involved, and a need for further study is indicated.

The favorable drainage area/lake area ratio of 80/1 lessens the impact of non-point source nutrients which may not be controllable.

VI. LITERATURE REVIEWED

Anderson, Jon K., 1969. Waterbury Reservoir, Washington County. VT Dept. of Fish and Game, Montpelier.

Anonymous, 1970. Waterbury Dam and Reservoir regulation manual. U.S. Army Corps of Engineers, Washington, D.C.

Morse, James W., 1974. Personal communication (status of Vermont water pollution control facilities as of January, 1974). VT. Dept. of Water Resources, Montpelier.

Vollenweider, Richard A., 1973. Input-output models. MS, Canada Centre for Inland Waters, Burlington, Ontario.

TRIBUTARY FLOW INFORMATION FOR VERMONT 7/9/74

LAKE COW 5011 WATERBURY RESERVOIR

TOTAL DRAINAGE AREA OF LAKE 112.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
501177	86.10	72.10	65.00	114.00	269.00	169.00	66.60	41.30	34.50	42.90	67.10	91.30	72.40	88.81
501121	13.20	15.60	13.50	34.20	80.40	50.60	19.90	12.30	10.30	12.80	20.10	27.30	21.60	26.56
501131	2.04	2.45	2.13	5.38	12.70	7.97	3.14	1.94	1.62	2.02	3.16	4.30	3.41	4.19
501152	52.62	62.10	53.63	136.00	320.00	202.00	79.40	49.30	41.10	51.20	80.00	109.00	86.30	105.99
501161	112.00	132.90	114.00	290.00	682.00	429.00	169.00	104.00	87.50	109.00	170.00	232.00	184.00	225.32

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 112.00
SUM OF SUB-DRAINAGE AREAS = 111.98

TOTAL FLOW IN = 2704.02
TOTAL FLOW OUT = 2702.50

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
501177	7	72	88.00						
	8	72	39.70						
	9	72	26.50						
	10	72	60.80						
	11	72	110.00						
	12	72	94.80						
	1	73	99.50						
	2	73	78.80						
	3	73	239.00						
	4	73	243.00						
	5	73	277.00						
	6	73	226.00						
501121	7	72	26.40	19	11.90				
	8	72	11.80	12	9.50				
	9	72	7.90	16	7.60				
	10	72	18.20	14	11.50				
	11	72	33.00	4	17.00				
	12	72	28.30	3	13.20				
	1	73	29.80	6	19.50				
	2	73	23.60	4	51.10				
	3	73	71.80	3	19.10				
	4	73	72.80	8	54.90	22	76.20		
	5	73	83.00	5	54.50	24	59.10		
	6	73	67.50	10	17.80				

TRIBUTARY FLOW INFORMATION FOR VERMONT 7/9/74

LAKE CODE 5011 WATERBURY RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
501131	7	72	4.20	15	1.90				
	8	72	1.90	12	1.50				
	9	72	1.20	16	1.20				
	10	72	2.90	14	1.80				
	11	72	5.20	4	2.70				
	12	72	4.50	3	2.10				
	1	73	4.70	6	3.10				
	2	73	3.70	4	8.10				
	3	73	11.30	3	3.00				
	4	73	11.50	8	8.70	22	12.00		
	5	73	13.10	5	8.60	24	9.30		
	6	73	10.60	10	2.80				
501152	7	72	105.00	15	47.30				
	8	72	47.30	12	37.70				
	9	72	31.60	16	30.20				
	10	72	72.50	14	46.00				
	11	72	132.00	4	67.90				
	12	72	113.00	3	52.40				
	1	73	119.00	6	77.80				
	2	73	93.80	3	204.00				
	3	73	286.00	3	76.30				
	4	73	290.00	8	219.00	22	304.00		
	5	73	331.00	5	217.00	24	236.00		
	6	73	269.00	10	71.00				
501161	7	72	208.00	15	11.00				
	8	72	141.00	12	13.00				
	9	72	33.80	16	12.00				
	10	72	69.10	14	17.00				
	11	72	228.00	4	13.00				
	12	72	198.00	3	23.00				
	1	73	271.00	6	272.00				
	2	73	399.00	4	17.00				
	3	73	536.00	3	381.00				
	4	73	595.00	8	585.00	22	611.00		
	5	73	599.00	5	590.00	24	1220.00		
	6	73	646.00	10	616.00				

APPENDIX B

PHYSICAL and CHEMICAL DATA

K - Value is less than indicated
J - Value known to be in error

STORET RETRIEVAL DATE 74/07/02

501101
44 23 06.0 072 46 06.0
WATERBURY RESERVOIR
50 VERMONT

11EPALES
3

2111202
0066 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/02	13	32 0000	19.1	9.6	72	40	7.20	10K	0.330	0.010	0.004	0.002
	13	32 0015	13.5	10.2		40	6.60	10K	0.400	0.020	0.004	0.004
	13	32 0050	6.3	11.8		40	6.65	10K	0.480	0.020	0.010	0.002
72/08/02	17	35 0000			96	70	8.60	14	0.070	0.050	0.008	0.005
	17	35 0004	23.9	9.8		60	8.70	12	0.070	0.060	0.007	0.004
	17	35 0015	20.8	5.6		70	6.70	13	0.220	0.100	0.012	0.007
	17	35 0030	18.5	4.5		60	6.60	10K	0.240	0.100	0.010	0.006
	17	35 0040	17.6	5.0		60	6.70	10K	0.250	0.110	0.010	0.006
	17	35 0050	16.5	5.5		60	6.60	10K	0.300	0.090	0.012	0.007
	17	35 0062	15.6	6.4		60	6.30	10K	0.350	0.060	0.016	0.008
72/10/05	12	40 0000			108	82	6.20	23	0.170	0.060	0.006	0.004
	12	40 0004	16.4	6.4		82	6.20	26	0.170	0.050	0.006	0.003
	12	40 0015	16.5	5.6		80	6.10	24	0.200	0.070	0.006	0.005
	12	40 0050	16.4	7.0		80	6.25	24	0.130	0.080	0.008	0.004
	12	40 0070	15.8	7.2		82	6.30	23	0.130	0.100	0.006	0.003

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/08/02	17	35 0000	5.8J
72/10/05	12	40 0000	0.9J

STORET RETRIEVAL DATE 74/07/02

501102
44 25 06.0 072 45 18.0
WATERBURY RESERVOIR
50 VERMONT

11EPALES 2111202
3 0020 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/02	14	08 0000	18.9	9.6	72	50	7.10	10K	0.320	0.010	0.006	0.003
	14	08 0008	19.0	9.8		60	7.10	10K	0.310	0.010K	0.004	0.002
72/08/02	18	10 0000			73	65	8.00	14	0.100	0.070	0.006	0.004
	18	10 0004	23.2	9.4		70	8.10	14	0.100	0.060	0.010	0.005
	18	10 0015	22.4	8.5		70	7.10	16	0.120	0.080	0.010	0.004
72/10/05	13	10 0000			144	80	6.50	24	0.130	0.080	0.007	0.006
	13	10 0004	17.2	8.4		80	6.50	24	0.120	0.080	0.007	0.005
	13	10 0012	16.9	8.4		80	6.50	24	0.120	0.060	0.006	0.004

22

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/02	14	08 0000	7.5J
72/08/02	18	10 0000	6.8J
72/10/05	13	10 0000	5.2J

APPENDIX C

TRIBUTARY DATA

K - Value is less than indicated
J - Value known to be in error

STORET RETRIEVAL DATE 74/07/02

S01121 LS501121
44 26 30.0 072 44 30.0
MILLER BROOK
50 15/MONTPELIER
T/WATERBURY RESERVOIR
MOSCOW RD BRIDGE ABOVE MOUTH
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15	11 30		0.191	0.400	0.020	0.005K	0.005K
72/08/12	11 55		0.222	0.820	0.023	0.005K	0.009
72/09/16	14 30		0.257	0.275	0.029	0.005K	0.006
72/10/14	13 20		0.170	0.200	0.056	0.005K	0.005K
72/11/04	11 30		0.221	0.630	0.031	0.005K	0.005K
72/12/03	10 10		0.420	0.230	0.029	0.005K	0.005K
73/01/06			0.399	0.100K	0.016	0.005K	0.005K
73/02/04	12 10		0.490	0.150	0.040	0.005K	0.010
73/03/03	15 30		0.420	0.100K	0.062	0.005K	0.010
73/04/08	10 30		0.400	0.250	0.115	0.005K	0.005K
73/04/22	09 00		0.430		0.020	0.005K	0.055
73/05/05	10 50		0.290	0.290	0.050	0.005K	0.005K
73/05/24	13 00		0.220	0.200	0.012	0.005K	0.005K
73/06/10	10 15		0.198	0.520	0.048	0.005K	0.005K

HC

STORET RETRIEVAL DATE 74/07/02

501131
44 27 00.0 072 44 00.0
BARROWS BROOK
50 15/MONTPELIER
T/WATERBURY RESERVOIR
AT CULVERT UNDER MOSCOW RD
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15			0.082	0.400	0.033	0.010	0.017
72/08/12	13 50		0.199	0.780	0.023	0.015	0.016
72/09/16	14 20		0.104	0.100K	0.036	0.005K	0.009
72/10/14	13 50		0.117	0.300	0.050	0.005K	0.009
72/11/04	11 15		0.160	0.520	0.028	0.005K	0.012
72/12/03	10 00		0.300	0.100K	0.020	0.005K	0.007
73/01/06			0.336	0.290	0.033	0.007	0.015
73/02/04	12 00		0.340	1.400	0.640	0.005K	0.020
73/03/03	15 00		0.357	0.280	0.160	0.005K	0.010
73/04/08	10 45		0.260	0.270	0.052	0.008	0.025
73/04/22	09 15		0.350	0.710	0.063	0.005K	0.085
73/05/05	12 10		0.198	0.220	0.026	0.005K	0.022
73/05/24	13 15		0.189	0.220	0.013	0.007	0.025
73/06/10	10 00		0.320	0.850	0.042	0.005K	0.015

STORET RETRIEVAL DATE 74/07/02

501141 LS501141
44 26 30.0 072 42 00.0
GOLD BROOK
50 15/MONTPELIER
T/WATERBURY RESERVOIR
AT RT 100 BRIDGE S OF STOWE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15	12 00		0.241	0.800	0.021		0.021
72/08/12	14 00		0.270	0.750	0.022	0.005K	0.006
72/09/16	15 00		0.210	0.200	0.032	0.005K	0.007
72/10/14	12 30		0.112	0.150	0.056	0.005K	0.005K
72/11/04	13 20		0.210	0.750	0.046	0.005K	0.009
72/12/03	10 30		0.364	0.100K	0.008	0.005K	0.007
73/01/06			0.350	0.200	0.016	0.005K	0.010
73/02/04	15 15		0.399	1.150	0.630	0.005K	0.010
73/04/08	11 00		0.320	0.130	0.033		0.006
73/04/22	09 40		0.520	1.050	0.050	0.005K	0.070
73/05/05	13 20		0.310	0.300	0.115	0.005K	0.005K
73/05/24	13 15		0.250	0.190	0.019	0.005K	0.010
73/06/10	10 30		0.220	0.140	0.023	0.005K	0.005K

STORET RETRIEVAL DATE 74/07/02

501151 LS501151
44 28 00.0 072 41 00.0
WATERBURY RIVER
50 15/MONTPELIER
I/WATERBURY RESERVOIR
AT BRIDGE N OF STOWE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15	12 00		0.271	0.450	0.038	0.010	0.013
72/08/12	14 20		0.240	0.270	0.023	0.005K	0.010
72/09/16	15 30		0.370	0.150	0.040	0.010	0.012
72/10/14	12 50		0.190	0.300	0.050	0.005K	0.016
72/11/04	12 45		0.200	1.340	0.252	0.005K	0.015
72/12/03	10 40		0.360	0.440	0.020	0.005K	0.010
73/02/04	13 55		0.399	0.290	0.084	0.005K	0.025
73/03/03	14 15		0.430	0.220	0.063	0.005K	0.015
73/04/08	11 15		0.378	0.682	0.105	0.009	0.055
73/04/22	10 00		0.370	1.240	0.025	0.005K	
73/05/05	14 15		0.240	0.380	0.052	0.005K	0.025
73/05/24	13 30		0.231	0.240	0.030	0.005K	0.026
73/06/10	11 00		0.330	0.445	0.039	0.005K	0.014

STORET RETRIEVAL DATE 74/07/02

501152 LS501152
44 27 00.0 072 43 30.0
WATERBURY RIVER
50 15/MONTPELIER
1/WATERBURY RESERVOIR
FROM SHORE BELOW STOWE AT CURTIS CONST
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/12	14	10	0.273	1.175	0.036	0.005K	0.012
72/09/16	14	10	0.350	0.350	0.120	0.046	0.090
72/10/14	12	40	0.221	0.350	0.058	0.016	0.066
72/11/04	13	00	0.310	1.200	0.130	0.006	0.050
72/12/03	11	00	0.510	0.170	0.044	0.009	0.039
73/04/08	11	30	0.480	0.250	0.039	0.010	0.045
73/04/22	10	20	0.500	2.310	0.545	0.010	
73/05/05	15	55	0.340	0.220	0.027	0.005K	0.015
73/05/24	13	45	0.315	0.300	0.058	0.007	0.020
73/06/10	10	45	0.357	0.480	0.260	0.005K	0.015

28

STORET RETRIEVAL DATE 74/07/02

501161 LS501161
44 22 00.0 072 47 00.0
LITTLE RIVER
50 1S/CAMELS HUMP
0/WATERBURY RESERVOIR
US RT 2 BRIDGE NW OF WATERBURY
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15	10 15		0.286	0.375	0.017	0.010	0.035
72/08/12	11 00		0.286	0.850	0.034	0.009	0.028
72/09/16	11 30		0.330	0.550	0.042	0.006	0.008
72/10/14	10 30		0.234	0.850	0.110	0.005K	0.012
72/11/04	10 30		0.182	1.000	0.046	0.005K	0.026
72/12/03	14 30		0.220	1.050	0.018	0.005K	0.016
73/01/06			0.240	0.230	0.013	0.005K	0.010
73/02/04	11 15		0.190	0.295	0.092	0.005K	0.010
73/03/03	11 30		0.460	0.110	0.020	0.005K	0.015
73/04/08	12 15		0.440	0.260	0.042	0.011	0.040
73/04/22	11 00		0.430	0.220	0.028	0.005K	0.015
73/05/05	09 15		0.410	0.290	0.076	0.005K	0.010
73/05/24	11 00		0.310	0.290	0.023	0.005K	0.020
73/06/10	14 00		0.280	0.170	0.038	0.005K	0.010